

Monitoring of tidal flat topography using Sentinel-1 data

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Synthetic Aperture Radar (SAR) data from the Sentinel-1 A/B satellites are used to monitor tidal flats in the Elbe River estuary in the German Bight. While the Elbe fairway is frequently sounded, the surrounding tidal flats are only surveyed every 6 years using airborne laser scanning. However, the high rate of erosion and sedimentation causes major changes in the topography like opening of new channels in much shorter timescales. A more frequent monitoring is necessary to ensure the safety of ships and also to be able to determine the effects of new underwater constructions and dredging for the planned deepening of the Elbe River.

While Earth Observation satellites frequently acquire images of the Wadden Sea area, only those acquired at low tide can be used to identify changes in tidal flats, since these are underwater during high tide. With Sentinel-1 A/B offering a 6-day repeat frequency and almost daily coverage in the German Bight, a low tide situation is captured approximately every two weeks, which is a sufficiently small interval for monitoring this area. As additional benefit, Sentinel-1 data are offered free of charge.

An automatic waterline detection algorithm was developed to delineate the land-water-line for an individual SAR image. It uses contrast-based edge detection and iterative thresholding for identification of edge pixels, yielding edges that match the visually identified edge. Automatic error corrections are applied to filter out smaller ships and buoys; however, some errors need to be corrected manually.

The pixel spacing in Sentinel-1 Interferometric Wide swath (IW) images usually acquired over the German Bight is 10 m, allowing for a 1 px offset this results in an accuracy of 20 m for the automatically derived waterlines. While this is lower than the resolution of an airborne laser scanning survey, the satellite data is available much more frequently and created with low effort for large areas. Its resolution and accuracy are sufficient to identify areas of major change in the tidal flats which is very helpful for local authorities.